# NDIA/Army Conference on Armaments for the Army Transformation

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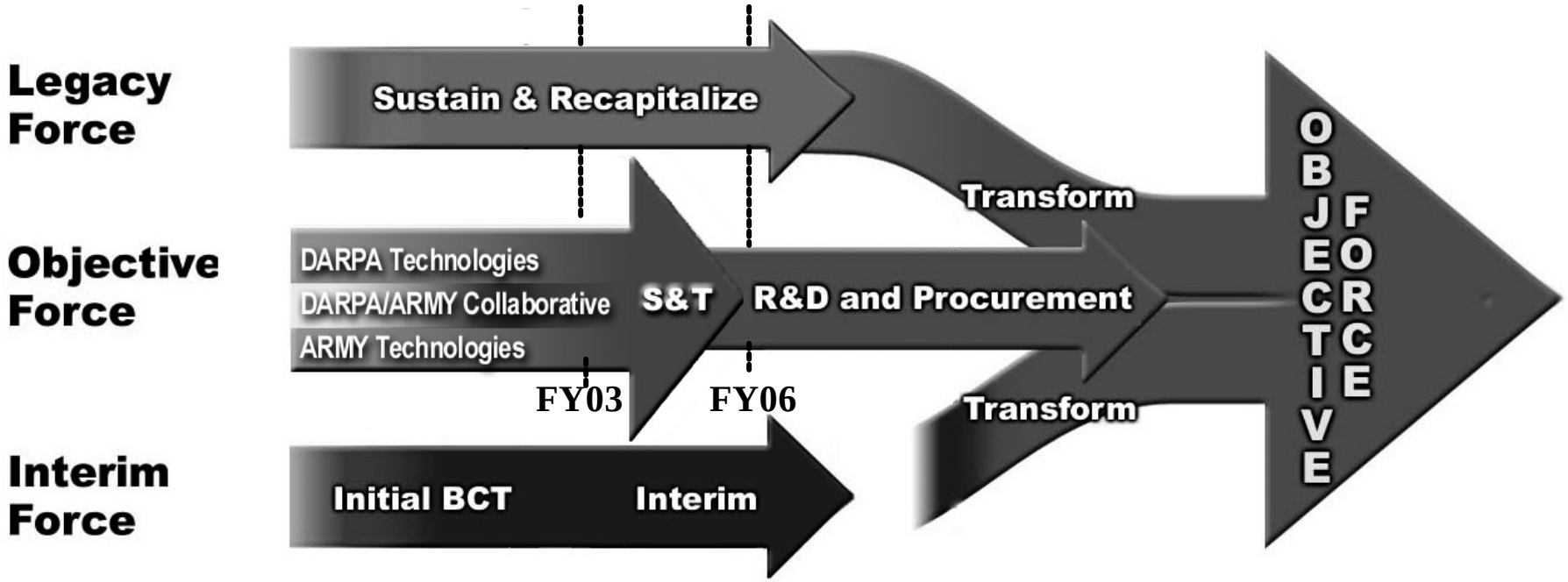
# The Army Transformation




***. . . Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable.***

# What is the FCS Program?

- *A collaborative program between DARPA and the US Army to evaluate and competitively demonstrate Future Combat Systems*
- **The FCS Program will:**
  - **Define and validate FCS design/operational concepts using modeling and simulation and surrogate exercises**
  - **Develop key enabling technologies for distributed lighter forces**
  - **Fabricate and test a multi-mission FCS Demonstrator to facilitate EMD and production**

***Simultaneously conduct a system/concept definition and design addressing the enabling technologies, allowing a critical decision in FY 03 and the creation of a systems demonstrator by FY 06***

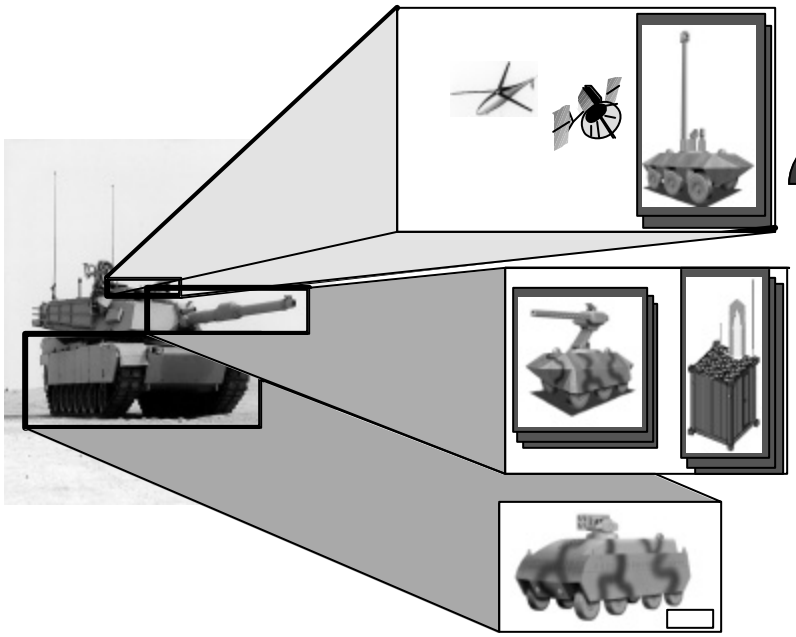
# Why DARPA?

- **DARPA's role in DoD is to be the technical enabler for innovation for national security**
- **DARPA serves as a temporary independent agent to catalyze radical innovation for the Army**
- **FCS must go back to the Army for full development**

# The Challenge

- **What makes the DARPA/Army Collaborative Demonstration Program so challenging?**
  - **Short-term, parallel development of system-of-systems concepts and key technology efforts**
  - **New operating concepts are being developed concurrently**
  - **System concept incorporates network warfare and relies heavily on robotics**

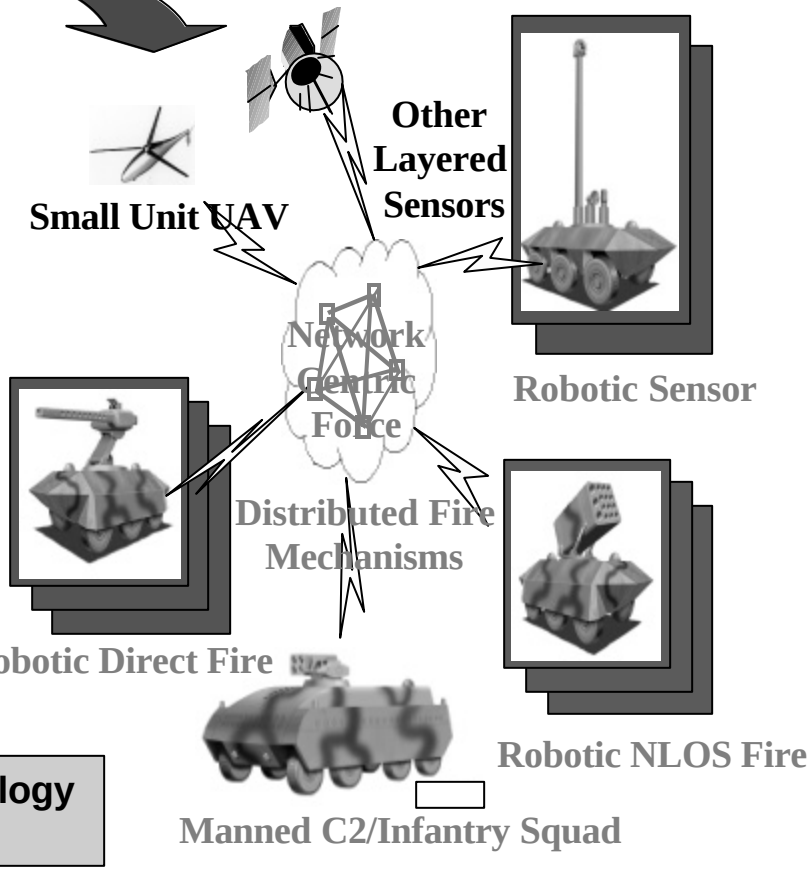
# Baseline System Concept



From This...

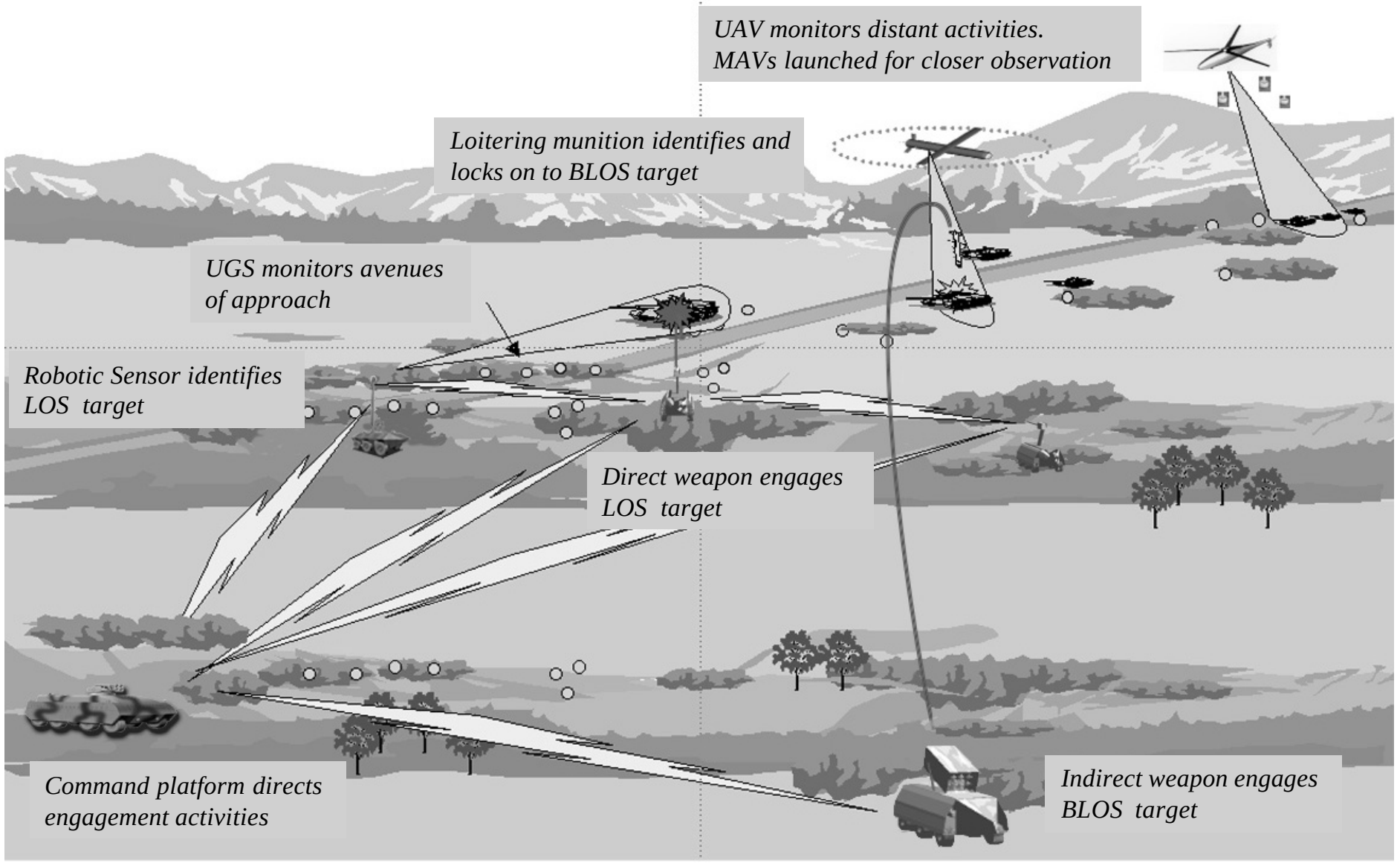
Network Centric Distributed Platforms

To This...



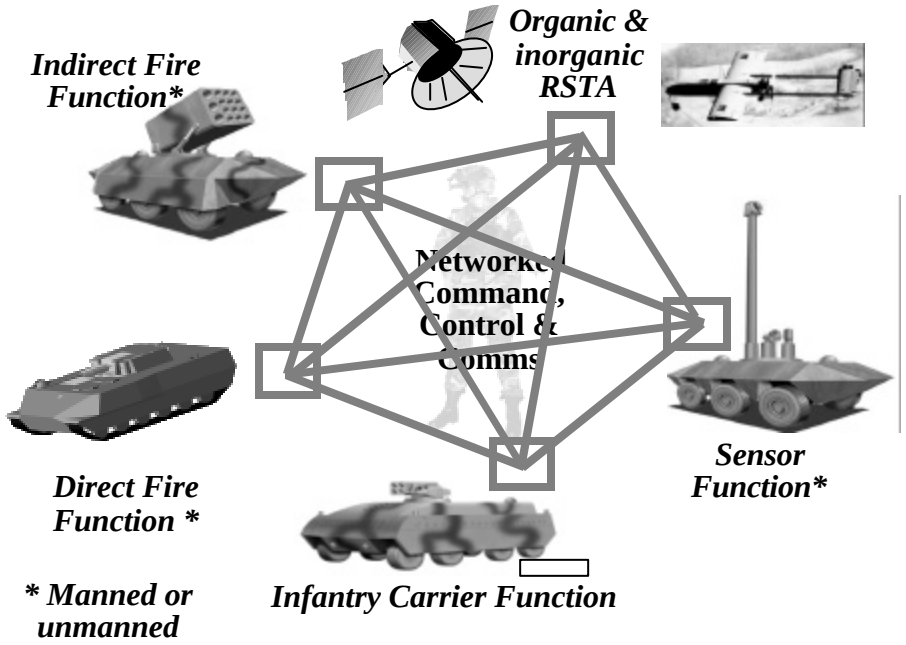

**Exploit Battlefield Non-Linearities using Technology to Reduce the Size of Platforms and the Force**

# FCS . . Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable

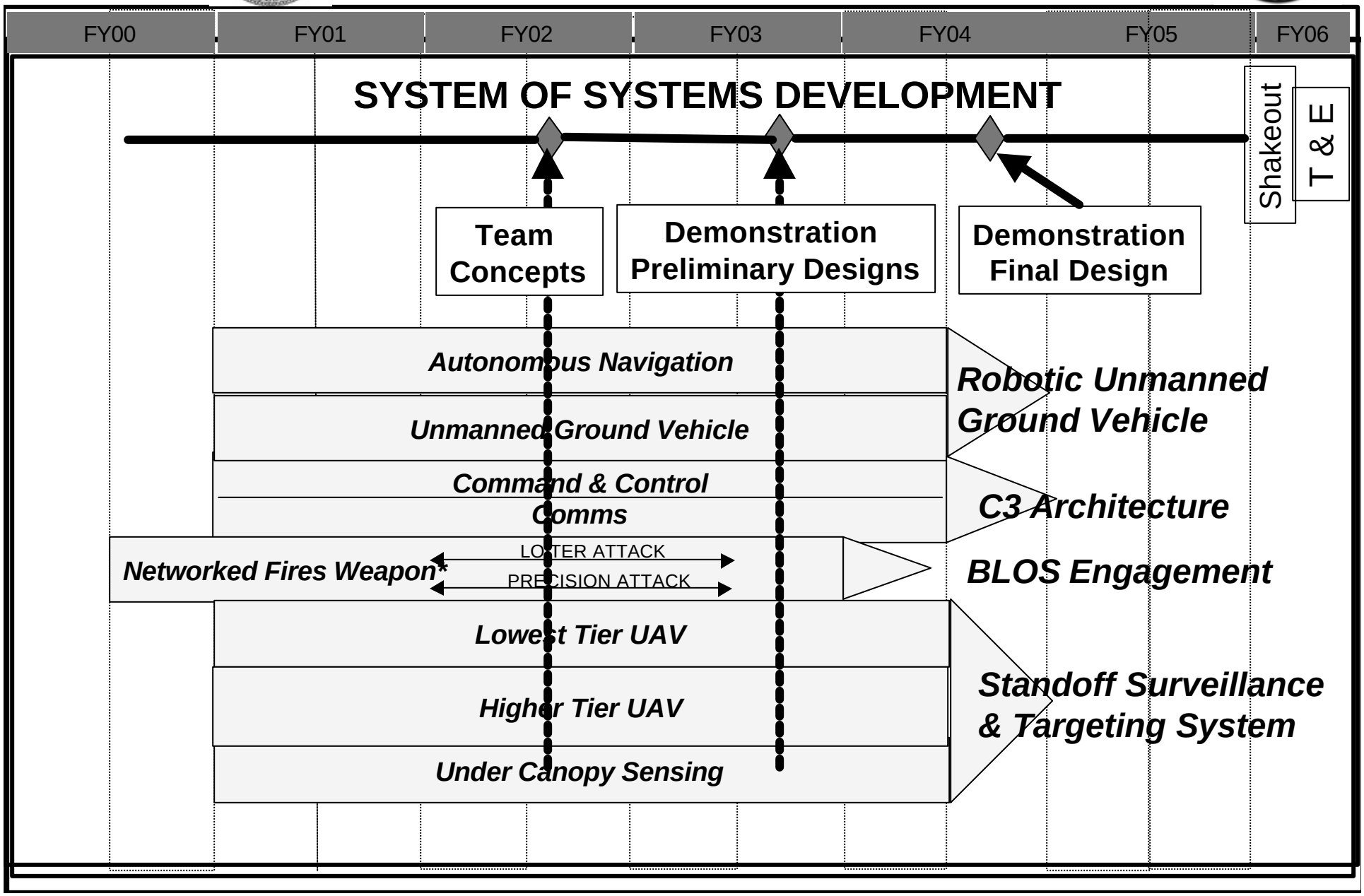


# What Makes FCS Different?

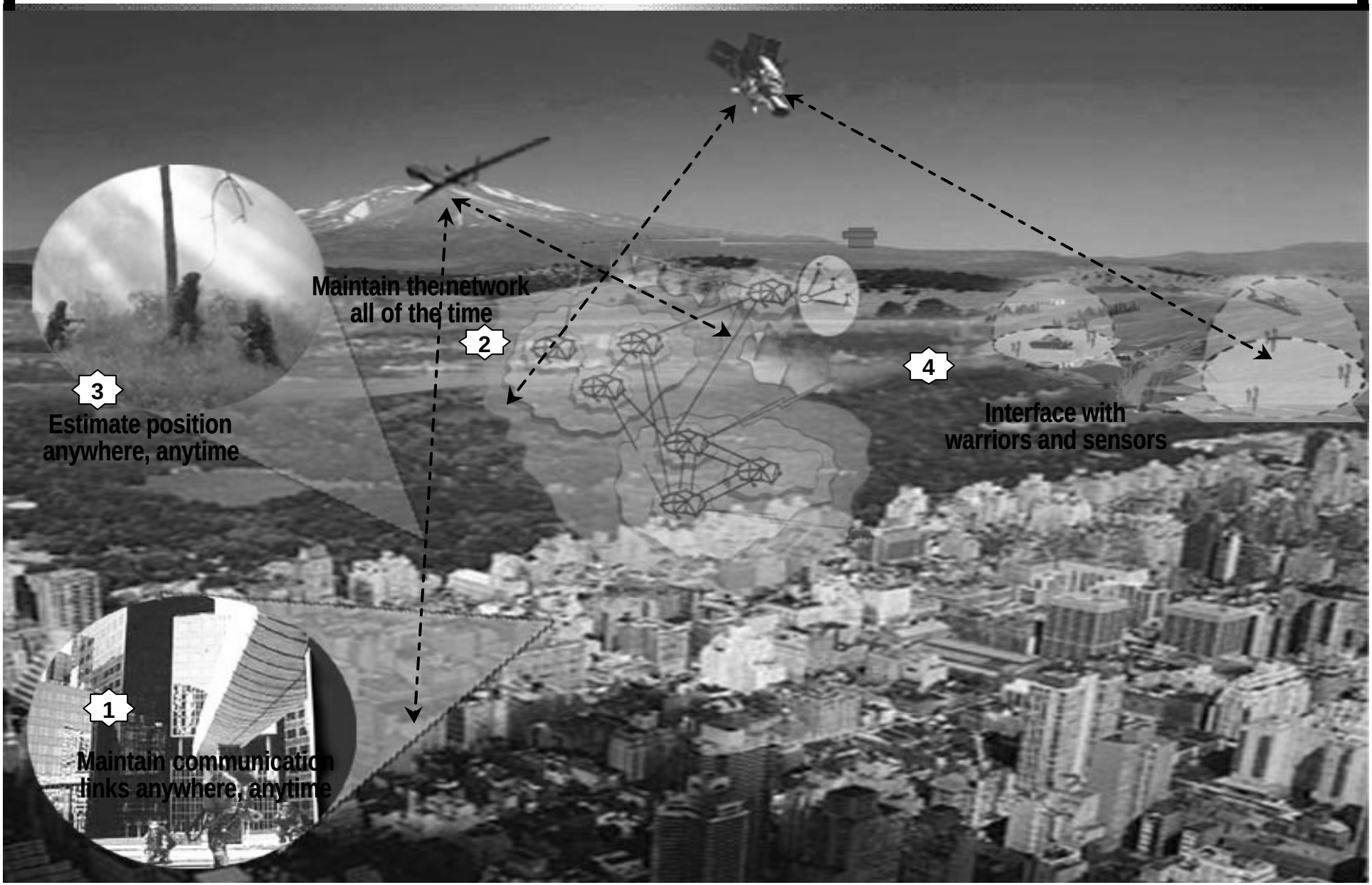
- **Network centric**
  - **Know precisely, in real-time, location of all friendly and enemy forces**
- **Robotics integrated into force**
  - **Amplify capability of manned elements**
  - **Multi-functional (RSTA, armed, sustainment)**
- **Increased reliance on extended range engagement**
  - **Organic plus strategic and tactical support**
  - **Long range ISR and precision fires**
- **Capable of air-mobile operations**
  - **Commercial and minimum DoD strategic and tactical lift**



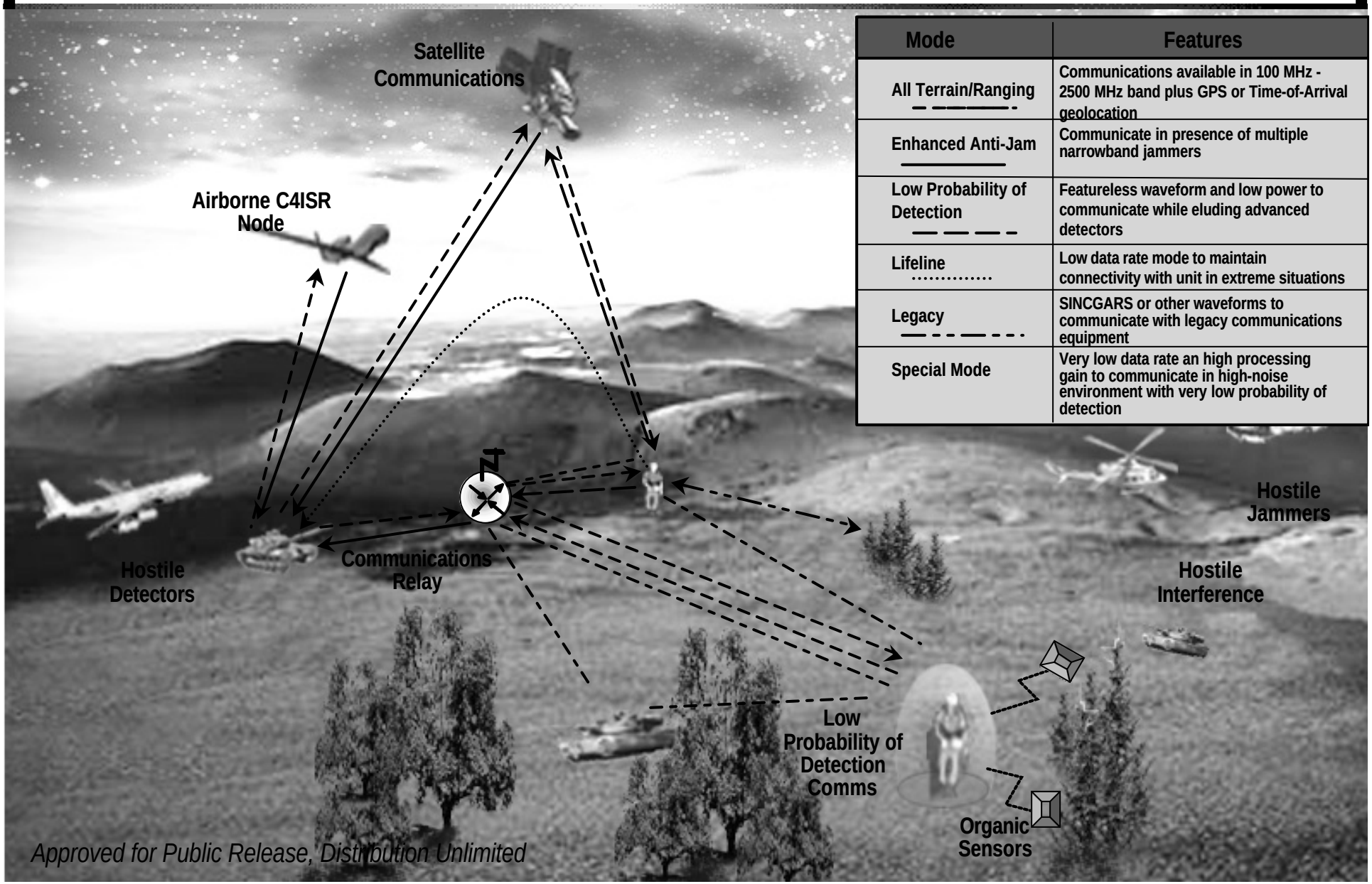
# FCS Technology Programs



# Small Unit Operations Situation Awareness System Concept

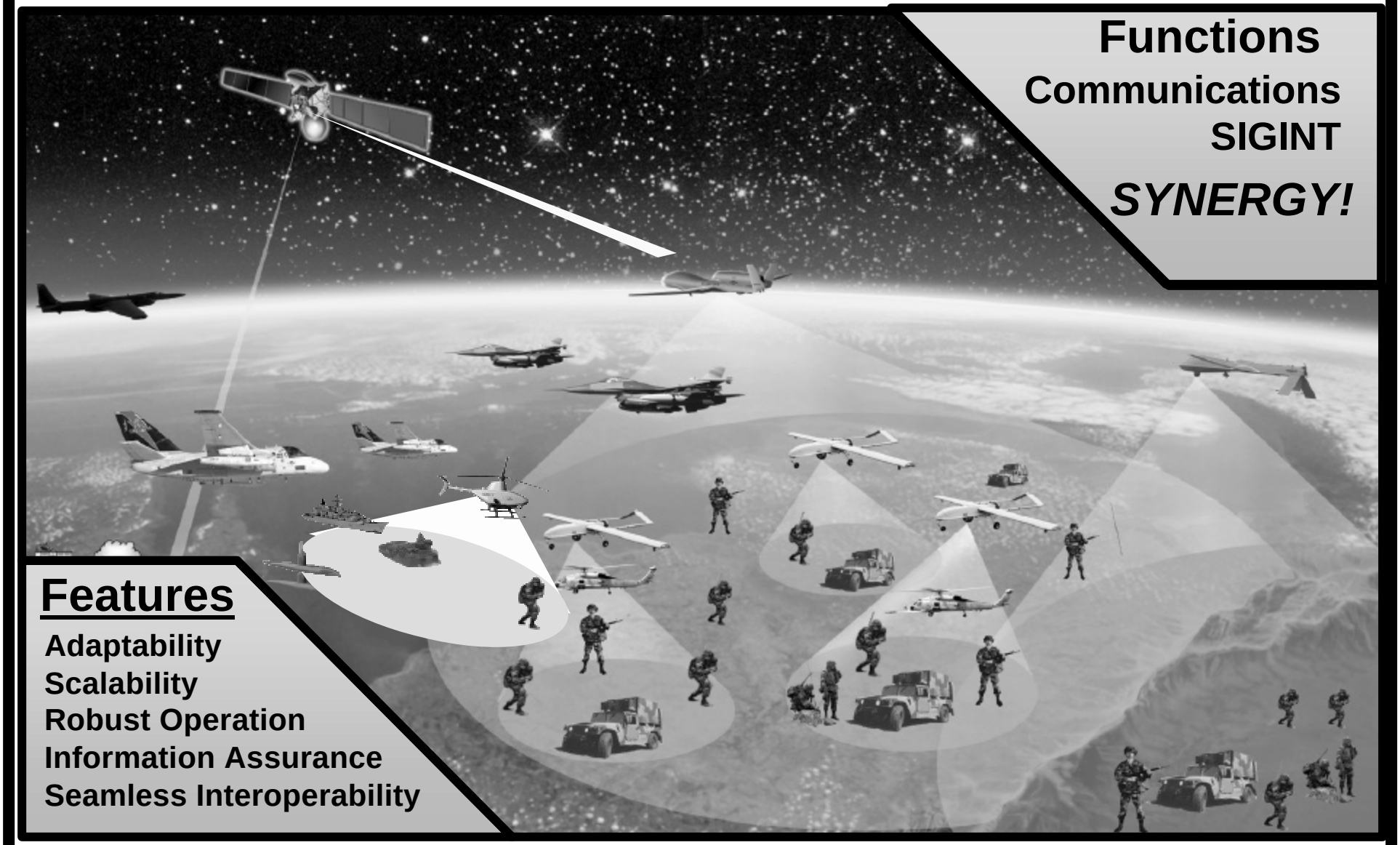


# SUO SAS is an Integrated Autonomous Communications Network, Navigation & Tactical Information Source for the Warrior




| Mode | Features |
|---|---|
| All Terrain/Ranging | Communications available in 100 MHz - 2500 MHz band plus GPS or Time-of-Arrival geolocation |
| Enhanced Anti-Jam | Communicate in presence of multiple narrowband jammers |
| Low Probability of Detection | Featureless waveform and low power to communicate while eluding advanced detectors |
| Lifeline | Low data rate mode to maintain connectivity with unit in extreme situations |
| Legacy | SINCGARS or other waveforms to communicate with legacy communications equipment |
| Special Mode | Very low data rate an high processing gain to communicate in high-noise environment with very low probability of detection |

# Adaptive C4ISR Node (ACN)



## Functions

**Communications**
**SIGINT**

***SYNERGY!***

## Features

**Adaptability**
**Scalability**
**Robust Operation**
**Information Assurance**
**Seamless Interoperability**

# ACN Program

- **Goal: Develop and demonstrate technologies to provide autonomous, assured communications and SIGINT in-theater**
- **Approach: Exploit commonalities between comms and SIGINT; use scalability, modularity to develop platform-independent solution**
- **Phase I (3 teams) started in FY98**
  - **Demonstrated narrowband, comms-only proof of concept**
- **Down selected to 2 teams for Phase II comms/SIGINT tech development and system design**
- **System design review - Jan. 02; Readiness review - Aug. 02**
- **Transition to Service with CDR-level design and demonstrated system performance in the laboratory (TRL >5)**

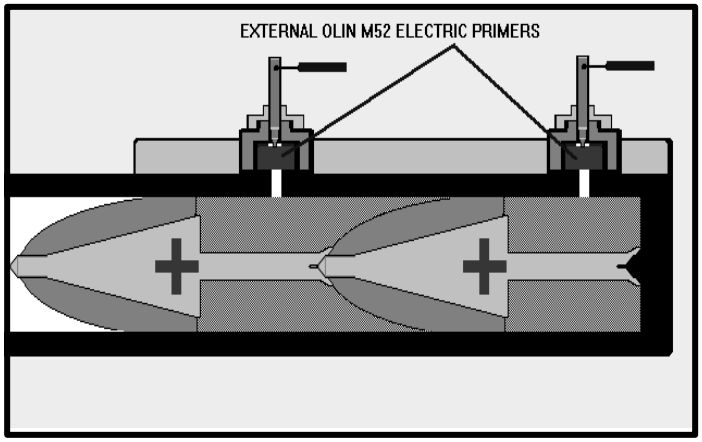
# Metal Storm

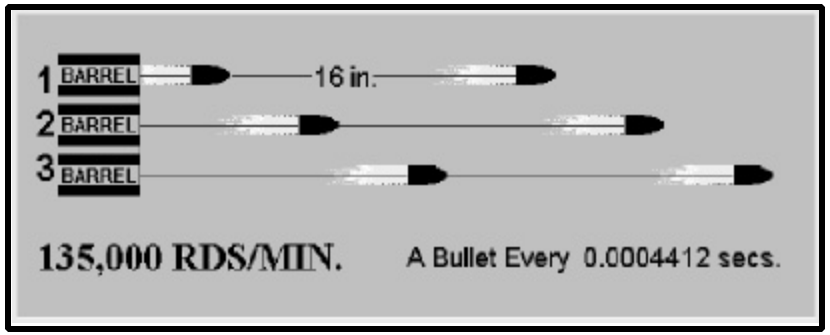
## *Revolutionary New Weapon Technology*

To develop a unique 100% solid state system for:

- tightly packing/ storing / transporting/ firing projectiles in multiple tubes
- electronically variable sequenced rate of fire, up to 1 Mil rds/min

Applications to a wide range of small arms and crew-served weapons for military and law enforcement.



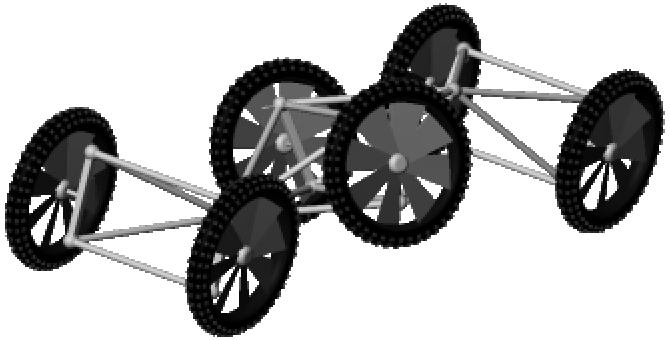




***The System has no conventional equivalent!***

# Uncrewed Ground Combat Vehicle

## Objective: Develop UGVs unrestrained by onboard crew

- **mass and volume elimination**
- **Ride quality and motion limits changes**
- **Human re-supply eliminated (food, water, fatigue)**

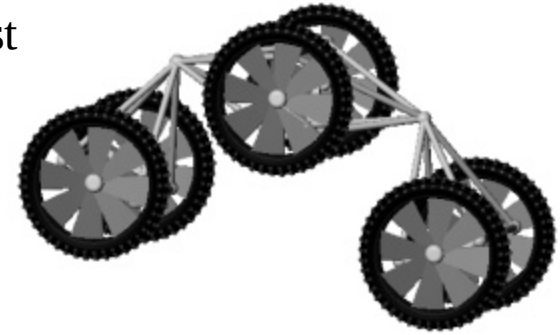


## Metrics

- **Endurance (14 days, 450+ km)**
- **Obstacle Negotiation (~ 1 m)**
- **Payload Fraction (>25%)**

**Retain awareness of:**

- Air deployability
- Resilience & reliability
- Signature
- Cost



## Vehicle Classes

**< 1 ton (RST+ payload: 150 kg)**

**~ 6 ton (Weapons payload: 1500 kg)**

# PerceptOR Objectives

Develop ground robot perception for off road mobility under a variety of terrain and environmental conditions relevant to FCS.

- **Strong emphasis on experiments in real world environments**



Several unique approaches

- Strong sensor fusion and object classification
- Air/ground coordinated perception
- Learning techniques
- Use of remote sensing data to assist classification
- Active and passive sensing strategies

**Inexpensive Surrogate ATV**

# NetFires

## New Military Capability

- Immediate firepower
- 5x-10x kills per ton vs current ordnance
- Large zone of influence
- Multimode seekers
- In-flight targeting
- Duration weapon
- Can provide BDA and imagery

## Family of Missiles

- Loitering Attack

- Precision Attack

## Designed for Deployability

- Logistic efficiency through containerization
- No platform or crew required

## Low Cost

- Reduced personnel and vehicles
  - LCC reduced > 50%
- CAIV design process
- Commonality of components and assembly

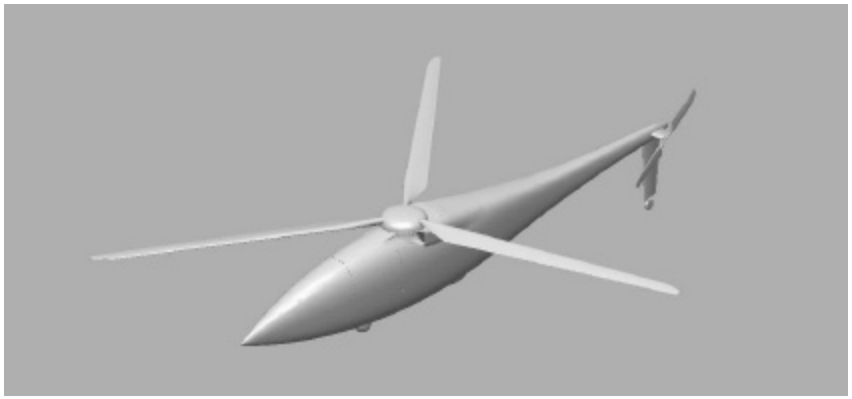
## Modular Vertical Launch

- Self locating / orienting
- Unmanned operation
- Not platform specific
- Can be vehicle appliqué

**Extensive testing (brassboard & propulsion, seeker captive flights, launcher, flight and endgame) accomplished prior to April 2003**

# A160 Program
## Long Range / Long Endurance VTOL UAV

**Advanced Rotor and Flight Control, Lightweight Composite Structure:**
**2500+ nm Range or 40+ hr Endurance with 300 lb payload**



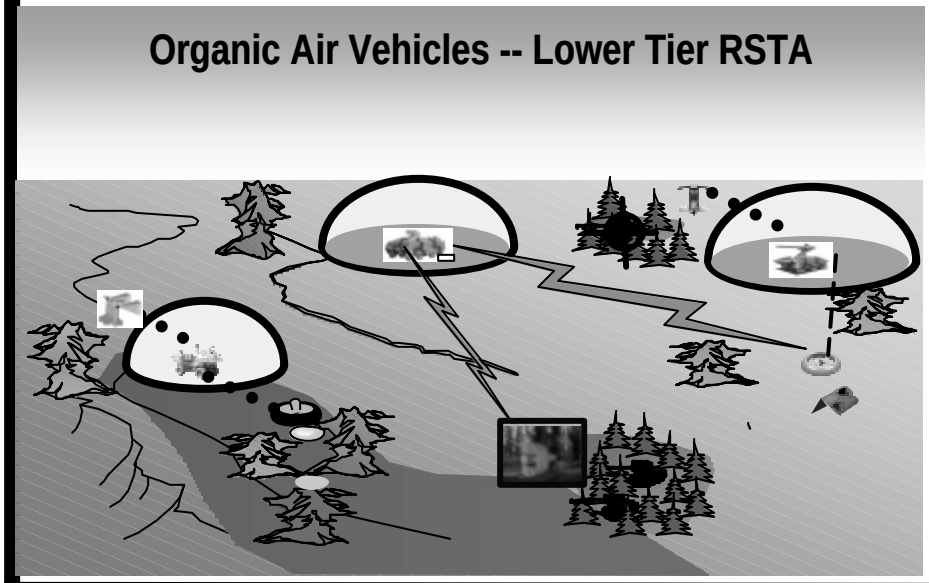
| | |
|---|---|
| Rotor Diameter | 36 ft |
| Fuselage Length | 35 ft |
| Payload Weights | 300-1000 lb |
| Takeoff Weight | 4000 lb |

**Vehicle Currently in Ground Test**

**Demos / Studies for 2003 FCS Decision:**

- SAR/GMTI radar, EO/IR, FOPEN Radar
- Data Link Network Payloads
- OAV, UGV, and UGS Deployment
- Combat Force Resupply
- All Weather Flight

# Organic Air Vehicle (OAV)




## Technical Objectives:

- **Flight stability and control in adverse weather**
- **Highly integrated electromechanical multifunction modules**
  - Collision avoidance
  - Guidance, Navigation, & Control
- **Adaptation and integration of useful payloads**
  - Real time day/night imaging
  - On-board processing

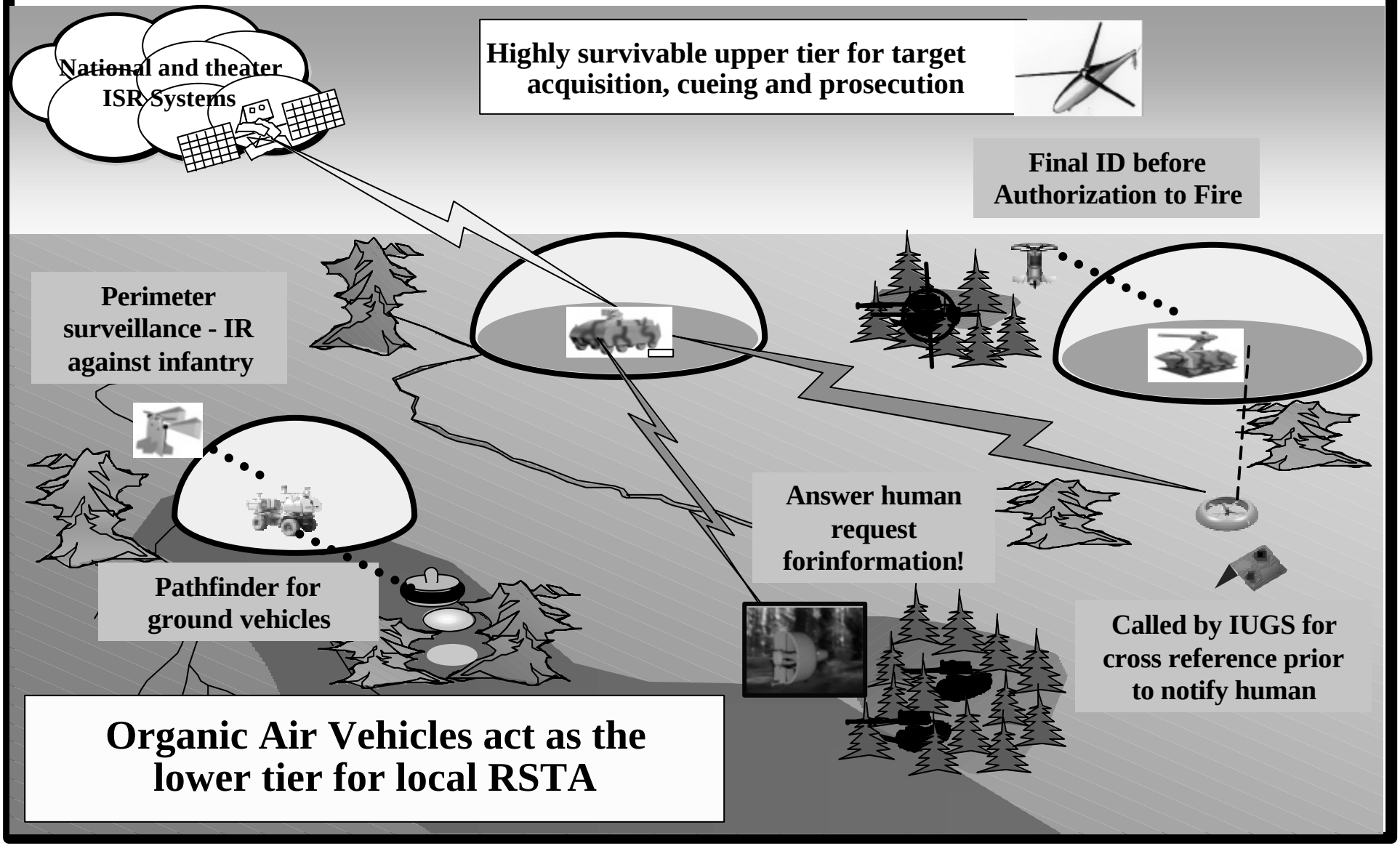
## Schedule:

| | FY01 | FY02 | FY03 |
|---|---|---|---|
| **Solicitation released** | ▽ | | |
| **Contracts awarded** | △ | | |
| **Auto GN&C demo** | ▽ △ | | |
| **Adverse weather demo** | | ▽ △ | |
| **FCS flight demo** | | | ★ |

## Military Relevance:

- **Enhances Situational Awareness for FCS Unit cell Operations**
  - Eliminates latency
- **Users: Army FCS**
- **Enables New Missions in Emerging Warfighting Environments**
  - Reconnaissance
  - Perch & Stare

# OAVs on the Battlefield

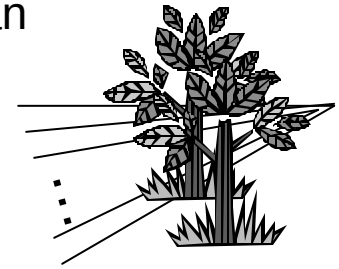


SPO
Special Projects Office

# Jigsaw:
## LADAR Sensing for Combat ID

DARPA

- **Program objective**
  - Develop LADAR systems for reliable combat ID by a human
- **Basic hypothesis**
  - LADAR can enable combat ID through:
    - 3-D sensing
    - Combining from multiple viewpoints
    - “Seeing through” holes in porous material (e.g., foliage)
- **Technical approach**
  - Data collections:  Simulations and field collect
  - Trade analyses for multiview LADAR on OAV-type platform
  - Prototype system design
  - Experiments with prototypes
- **FCS Transition**
  - Demonstration of Combat ID using OAV scenarios
  - Stressing targets (in hide, urban, etc.)



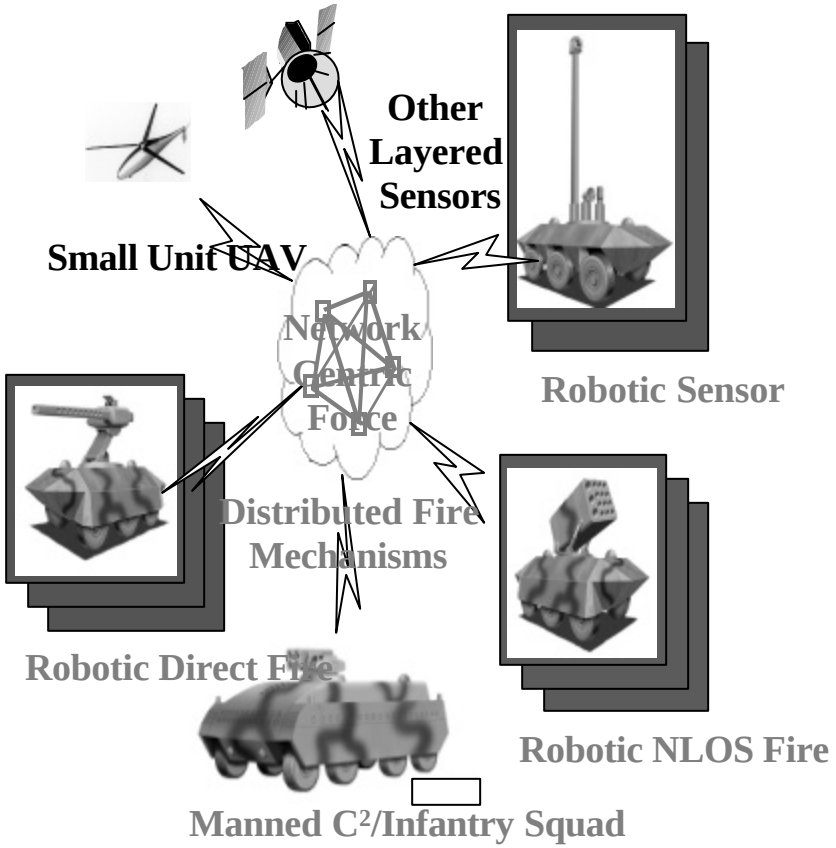
# FCS Command and Control

## Approach

Attempting to integrate the stove-piped Battlefield Functional Areas

## Top Technical Challenges

- Developing an integrated $C^2$ architecture derived from selected BFAs for a FCS unit cell
- Insuring connectivity to an FCS Commander through an interactive display




## Users

- Objective Force units
- Connectivity to legacy units

## Goals

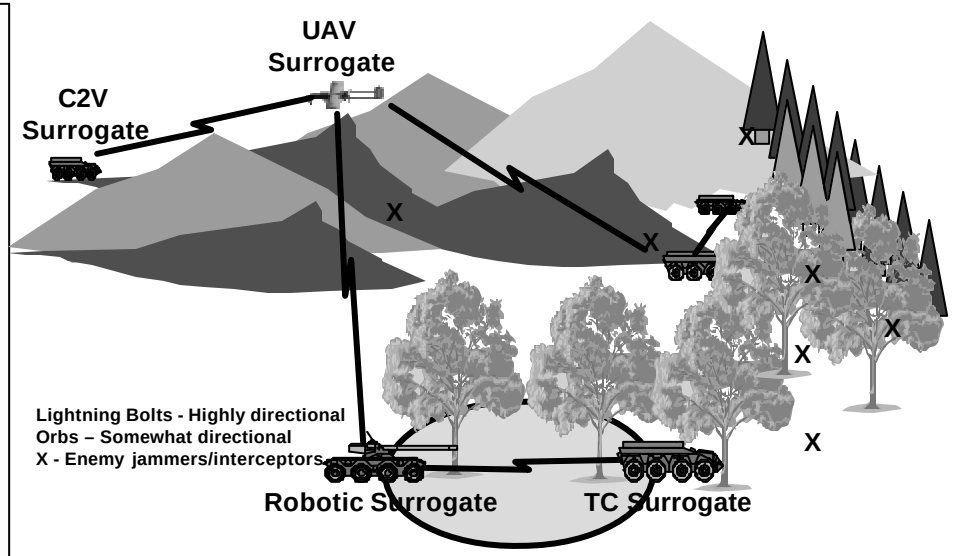
FY03

- Develop an integrated scaled $C^2$ Architecture
- Simulate and demonstrate a $C^2$ element of a Unit Cell

# FCS Communications

## *Goal*

- ***Provide assured, high data rate networked communications that is LPD and A/J with quality of service for real-time and non-real time applications in a heterogeneous environment with 1000s of nodes.***
- ***Demonstrate Notional FCS Cell at TRL-5 for PDR by 15 Apr 03***
- ***Show Scaling Across Multiple FCS Cells in Simulation by 15 Aug 03***




**Technical Challenges**

- **High Data Rates for Low Latency Real-Time Traffic (Robotic and Fire Control)**
- **Low Probability of Detection (Sensor to Decision Maker)**
- **Anti-Jamming (Decision Maker to Shooter)**
- **Seamless, Multi-band Mobile Ad Hoc Networking with Directional Antennas**
- **Quality of Service for Real-Time and Non-Real-Time Traffic**
- **RF Information Assurance (Network Layer and Below)**

- **Backup slides**

# FCS Concept Development

- **DARPA Program Manager**
  - **LTC Marion Van Fosson, USA**

- **Four contractor teams**
  - **The Boeing Team**
  - **Team Gladiator (Consortium)**
  - **Team Full Spectrum**
  - **Team FoCus Vision (Consortium)**

# FCS Major Technology Challenges


- **Autonomous Unmanned Ground Vehicles**
  - **Uncrewed Ground Combat Vehicle**
  - **PerceptOR: Perception for Off Road Mobility**
- **Maneuver BLOS**
  - **Networked Fires (NetFires)**
- **Organic All-Weather Targeting Vehicles & Sensors**
  - **A160**
  - **Organic Air Vehicle**
  - **JIGSAW: LADAR Sensing for Combat ID**
- **Networked Command, Control & Communications**
  - **Integrated C2 Architecture**
  - **FCS Communications**

# UGCV Status

## Awarded 8 Agreements in January

### RST and Weapons Categories Studies

OMNITECH ROBOTICS
United Defense
SRI
MIT
Raytheon Command, Control, Communication and Information Systems
AeroVironment
UQM
Carnegie Mellon
TIMONEY TECHNOLOGY
PEI Electronics Inc.
BOEING
GENERAL DYNAMICS Land Systems
MAGNET MOTOR
US Army Corps of Engineers

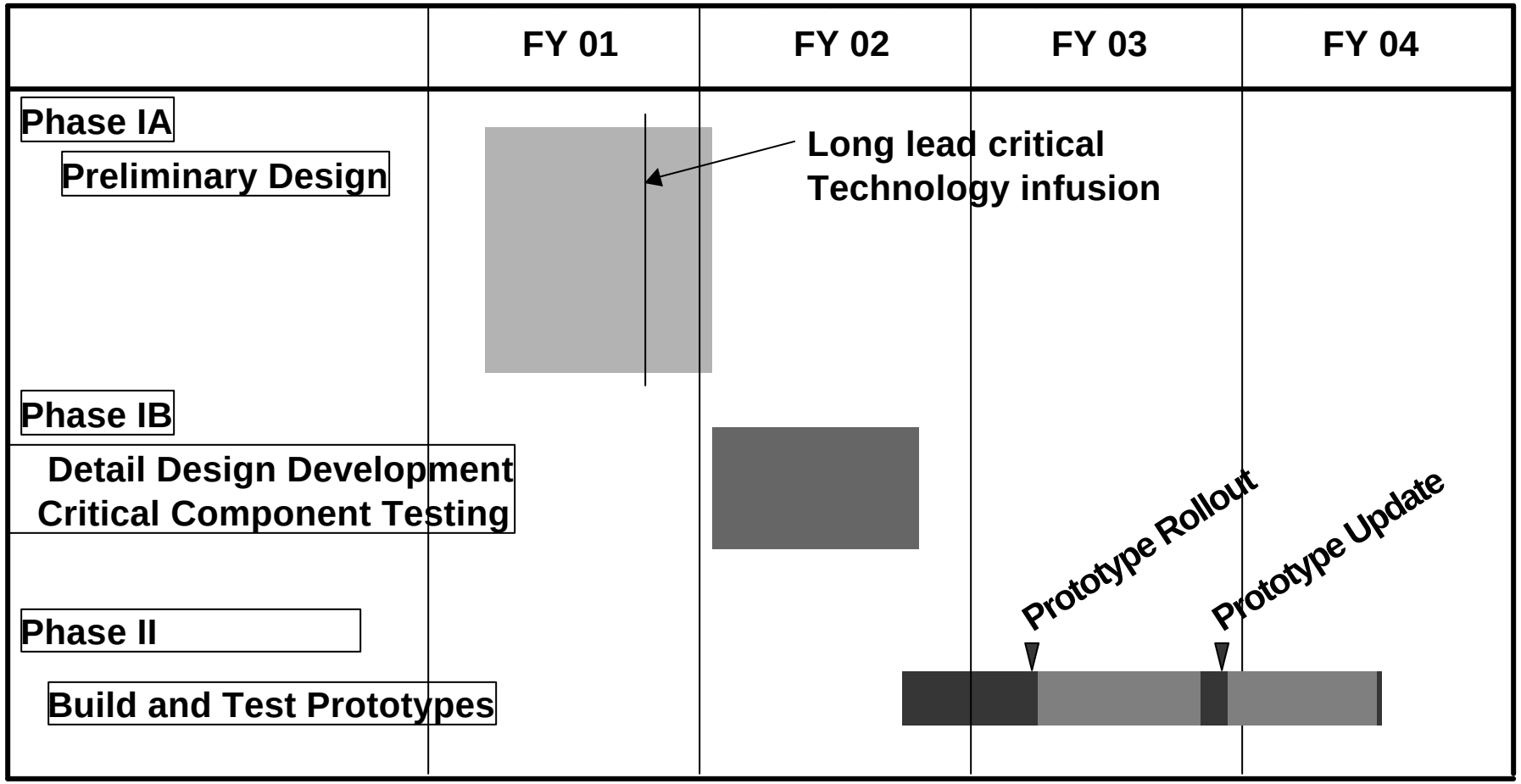
### RST Category Study

iRobot
PRODUCT RESOURCES INCORPORATED
CATERPILLAR
Raytheon
planet
Battelle ... Putting Technology To Work
Carnegie Mellon
The MultiRobot Lab
LOCKHEED MARTIN
Sandia National Laboratories
Rod Millen
BAE SYSTEMS
NIST
Carnegie Mellon
CATERPILLAR
GENERAL DYNAMICS Robotic Systems
Carnegie Mellon
Engine Research Assoc.
Patrick Power Products
Percep Tek

### Weapons Category Study

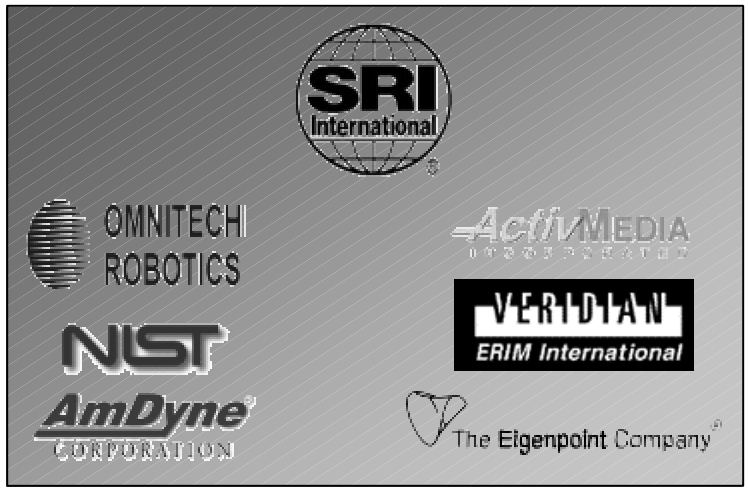
SAIC An Employee-Owned Company
JPL
CEM
United Defense
Georgia Tech
Stanford University
USF

# UGCV Plan


FY 01
FY 02
FY 03
FY 04
Phase IA
Preliminary Design
Long lead critical
Technology infusion
Phase IB
Detail Design Development
Critical Component Testing
Prototype Rollout
Prototype Update
Phase II
Build and Test Prototypes

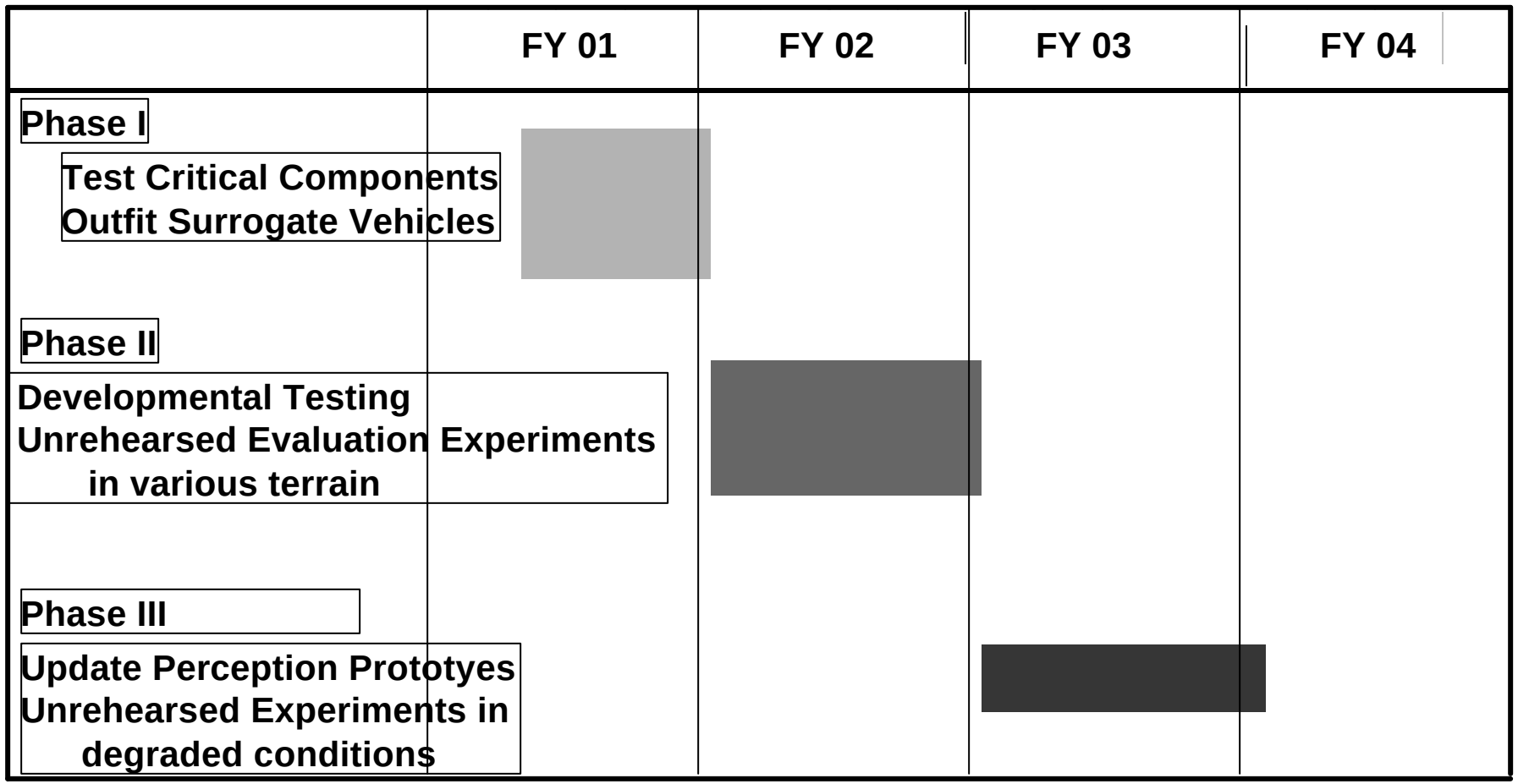
# PerceptOR Teams

Awarded 4 Agreements in March 2001

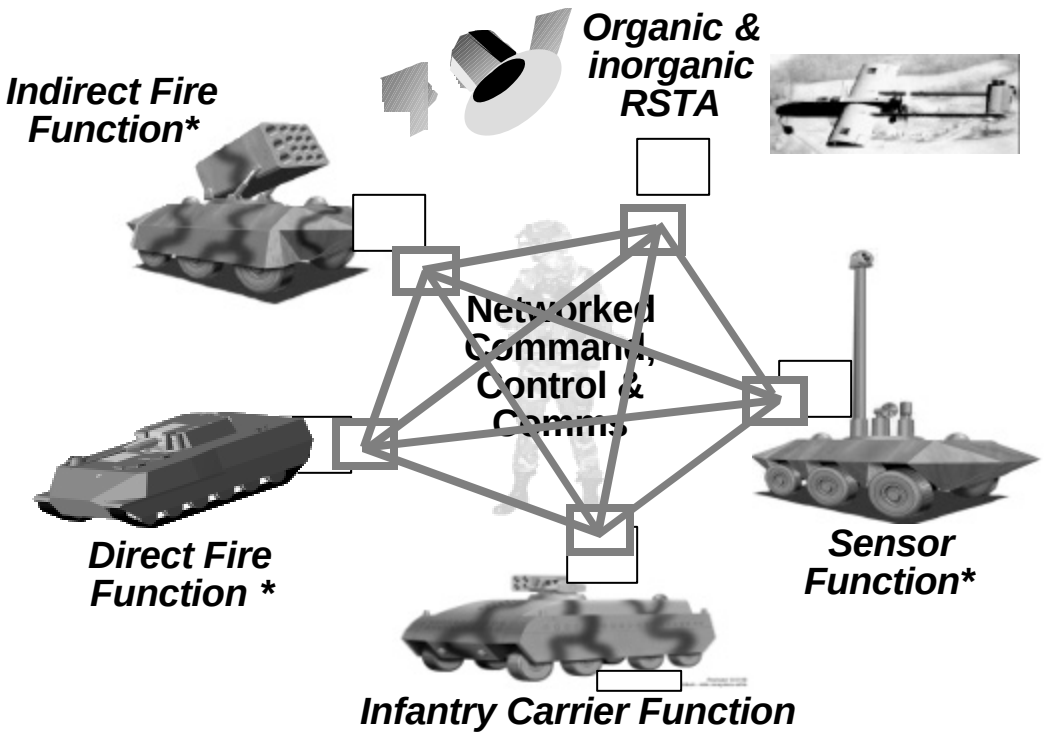


# PerceptOR Plan



# Major Technology Challenges

- **Autonomous Unmanned Ground Vehicles**
- **Maneuver BLOS**
  - **Networked Fires**
- **Organic All-Weather Targeting Vehicles & Sensors**
- **Networked Command, Control & Communications**




** Manned or unmanned*